THE

ONTARIO WATER RESOURCES

COMMISSION

BIOLOGICAL EVALUATION

of the

POLLUTION STATUS OF

JACKFISH BAY, LAKE SUPERIOR

1969

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by

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ONTARIO WATER RESOURCES COMMISSION

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SUMMARY AND RECOMMENDATIONS

During the month of August 1969, a biological survey was undertaken to determine the nature, degree and extent of the effects of bleached kraft wastes from the Kimberly-Clark Pulp and Paper Company Limited on the waters of Jackfish Bay, Lake Superior.

The observed physical, chemical and biological conditions support the conclusion that toxic and organic pollution exists throughout Moberly Bay (the western arm of Jackfish Bay) with complete recovery evident at an approximate distance of 1-1/4 miles from the mouth of Blackbird Creek.

In view of existing conditions in Jackfish Bay and considering the incapability of Blackbird Creek to assimilate or reduce wastes components to the extent necessary for the adequate protection of Jackfish Bay waters, it is recommended that:

1) Any damage to the environment resulting from the discharge of mill waste effluents should be restricted to the Blackbird Creek, Lake 'A', and Lake 'C' water-course system.

2) Because of the inability of Lake 'A' and Lake 'C' under present operating conditions to adequately control the discharge of suspended solids, and because of the need to prevent the discharge of suspended solids materials into Moberly Bay, the Company should install suitable treatment facilities at the mill (such as a mechanical clarifier with sludge dewatering equipment) to remove the bulk of the suspended solids materials from the mill waste effluents and thereby control the amounts of suspended solids materials ultimately discharged to Moberly Bay.

3) The Company install suitable treatment facilities which will reduce the toxicity of the waste discharges to a sub-lethal level at the mouth of Blackbird Creek and prevent further organic enrichment of Jackfish Bay.

4) Steps be taken by the Company to rectify aesthetically-objectionable conditions along the Trans-Canada highway resulting from the use of Blackbird Creek for waste translocation.

BIOLOGICAL EVALUATION OF THE POLLUTION STATUS OF JACKFISH BAY, LAKE SUPERIOR

INTRODUCTION

A biological survey was carried out on Jackfish Bay of Lake Superior during the month of August 1969. The purpose of the survey was to determine the nature, degree and extent of water quality impairment which has resulted from the discharge of bleached kraft wastes from the Terrace Bay Mill of the Kimberly-Clark Pulp and Paper Company Limited, Terrace Bay, Ontario.

DESCRIPTION OF THE STUDY AREA

General features of the study area are illustrated in Figure 1. The Blackbird Creek Watershed drains an area of approximately 24 square miles, most of which lies within the Township of Terrace Bay. The creek rises in the vicinity of Terrace Bay at a general elevation of 950 feet and flows in a south-easterly direction for approximately ten miles to Jackfish Bay of Lake Superior, at an elevation of 600 feet.

Enroute to Jackfish Bay, the creek passes through two lakes. The first, known only as Lake 'A', originally occupied a surface area of 47 acres with depths ranging to 20 feet (Rowley, 1962). The second, known as Moberly Lake or Lake 'C', was reported by the same author as having a surface area of 69 acres and a maximum depth of 21 feet.

Flow records for Blackbird Creek are unavailable; however, pro-rating from area/flow relationships of seven watersheds draining to the northern shore of Lake Superior,

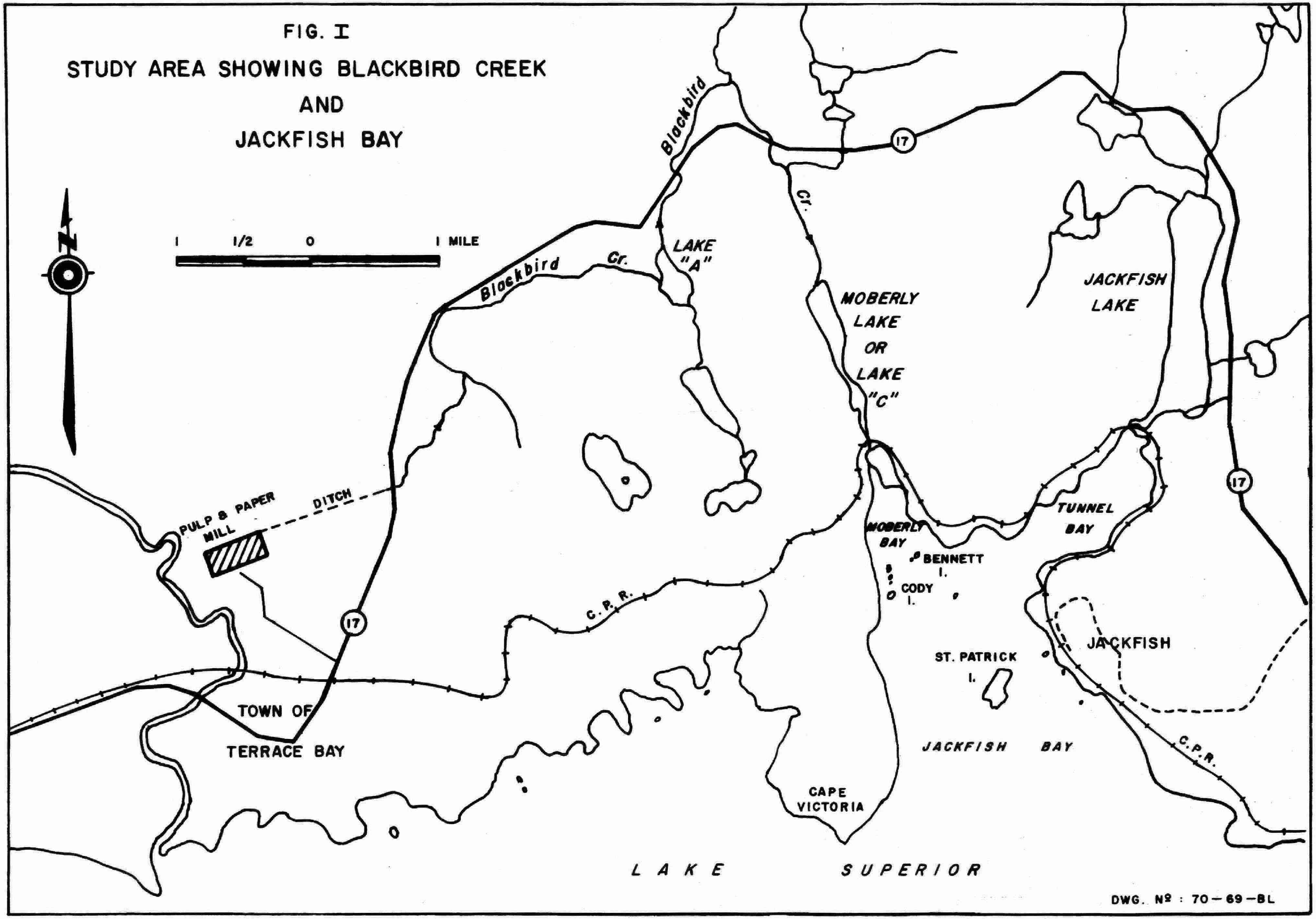


FIG. I
STUDY AREA SHOWING BLACKBIRD CREEK
AND
JACKFISH BAY
1 1/2 0 1 MILE
Blackbird
Cr.
Blackbird Cr.
LAKE "A"
MOBERLY LAKE OR LAKE "C"
JACKFISH LAKE
17
PULP & PAPER MILL
DITCH
C. P. R.
TOWN OF
TERRACE BAY
MOBERLY BAY
BENNETT I.
CODY I.
TUNNEL BAY
JACKFISH
ST. PATRICK I.
JACKFISH BAY
C.P.R.
CAPE VICTORIA
LAKE SUPERIOR
DWG. Nº : 70—69—BL

the mean natural flow of Blackbird Creek has been estimated to be 24 ft. ^{3}/sec. (approximately 13 million gallons/day) at the creek mouth.

Jackfish Bay of Lake Superior consists of a large outer expanse of open water with two inner arms, referred to hereafter as Moberly Bay, the western arm and Tunnel Bay, the eastern arm. The discharge of Blackbird Creek is to Moberly Bay.

No use is made of the Creek/Lake system from the mill to Moberly Bay other than for wastes disposal. Process wastes from the Kimberly-Clark Pulp and Paper Company Limited, Terrace Bay Mill are discharged via an open ditch to the headwaters of Blackbird Creek. The mill operates a conventional bleached kraft process which results in a daily discharge of 20 million gallons of waste water.

The Tunnel Bay arm and open waters of Jackfish Bay receive limited sport fishing and pleasure boating pressure from the tourist camp located on Jackfish Lake and the summer residents of the community of Jackfish.

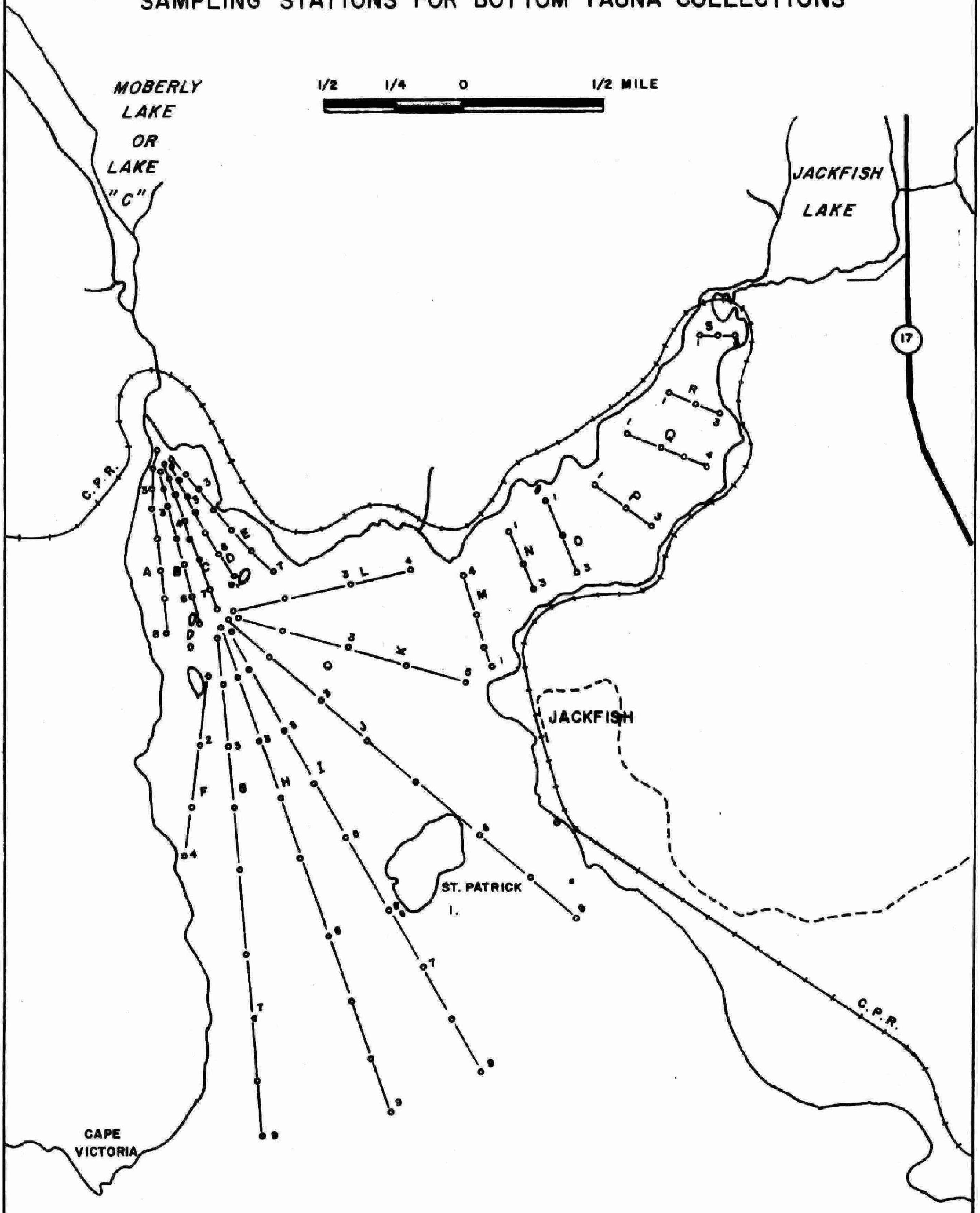
SURVEY METHODS

Standing crops of bottom fauna were examined at 108 sampling sites on Jackfish Bay (Figure 2). Benthic communities of Tunnel Bay are uninfluenced by wastes inputs and for the purposes of this report, serve as the control for comparison with communities of Moberly Bay.

All samples were secured with a Ponar dredge. After noting the characteristics of the sediment the sample was washed through a 24-mesh-per-inch (0.0256 inch opening) sieve and the organisms were separated and removed from extraneous materials. All samples were preserved with

FIG. 2

SAMPLING STATIONS FOR BOTTOM FAUNA COLLECTIONS



DWG. Nº : 70-70-BL

ethanol and returned to the laboratory for subsequent identification and enumeration.

On August 20, nine sites on Jackfish Bay were visited and depth-composite water samples were secured with a Kemmerer water sampler for water chemistry analyses.

EXPLANATION OF BIOLOGICAL EVALUATION

In the present study, emphasis was placed on the examination of bottom fauna communities. The term bottom fauna refers to animal life visible to the unaided eye, which live either in or on the sediments at the bottom of the bay. Because of the varied, responsive and immobile nature of benthic communities, as well as their importance as a source of fish food, this group of animals represents one of the most useful forms of aquatic life for making an accurate assessment of water quality. The assessment is based on the relative composition and abundance of tolerant and intolerant species. The degree of upset of the community balance that is detected provides a good indication of the nature and degree of water quality impairment as well as direct evidence of an effect on the aquatic life of the receiving water.

SURVEY FINDINGS

No attempt was made to examine the biological life of the Creek/Lake system. It was noted, however, that a large flock of sea gulls was present on Lake 'A'. Their presence, it was discovered, related to an abundant food supply of rat tailed maggots (Eristalis sp.), an organism which is unique in its ability to withstand septic conditions. This indication of septic conditions in Lake 'A' is significant to the extent that it points out the inability of the Creek/Lake system to function in

biological stabilization of bleached kraft wastes, a point which is further indicated by the results of BOD and solids determinations for samples collected along the system by personnel of the Division of Industrial Wastes in August, 1969.

From Jackfish Bay at large, a total of sixteen taxa of bottom fauna were identified (Table 1 of the Appendix). Fifteen of these forms were present in Tunnel Bay, the clean water environment, whereas only seven taxa were obtained in the Moberly Bay collection. Further, of the seven taxa listed as being present in Moberly Bay, five were detected only at the outermost sampling sites. Most of the Moberly Bay samples contained only pollution-tolerant sludgeworms and midge larvae.

Among the fauna present in Tunnel Bay were three taxa of caddisfly larvae, the opposum shrimp, *Mysis relicta*, and the amphipod *Pontoporeia affinis*, all forms which are considered to be intolerant of impaired water quality. Of these, only the opposum shrimp would be excluded from the fauna of Moberly Bay owing to some natural factor, in this case, depth. The amphipod *P. affinis* which normally frequents deep waters occurred in high densities at depths as shallow as five feet in Tunnel Bay and would be expected to occur throughout Moberly Bay under normal circumstances.

Severe toxic pollution, demonstrated by the absence of all bottom fauna, was detected at stations A1, B1, B2, C1, C2, D1 and E1 on Moberly Bay.

Reduction of toxicity with increased distance away from the mouth of Blackbird Creek owing to dilution was accompanied by the re-establishment and successive increase in numbers of pollution-tolerant organisms. This was particularly noticeable along the A, B and C transects.

Maximum response of the benthic communities to organic enrichment occurred at stations A6 and B5 on Moberly Bay and stations G1, H1, I1 and J1 on Jackfish Bay proper. The occurrence of high densities of pollution-tolerant sludgeworms at these sampling sites was an indication that dilution of toxicants to sub-lethal concentrations was complete. Restoration of normal water quality followed at the adjacent lakeward stations. Simultaneously, densities of sludgeworms declined and indigenous clean water fauna were re-established. This process appeared complete at the number three stations along transects G, H, I and J on Jackfish Bay proper.

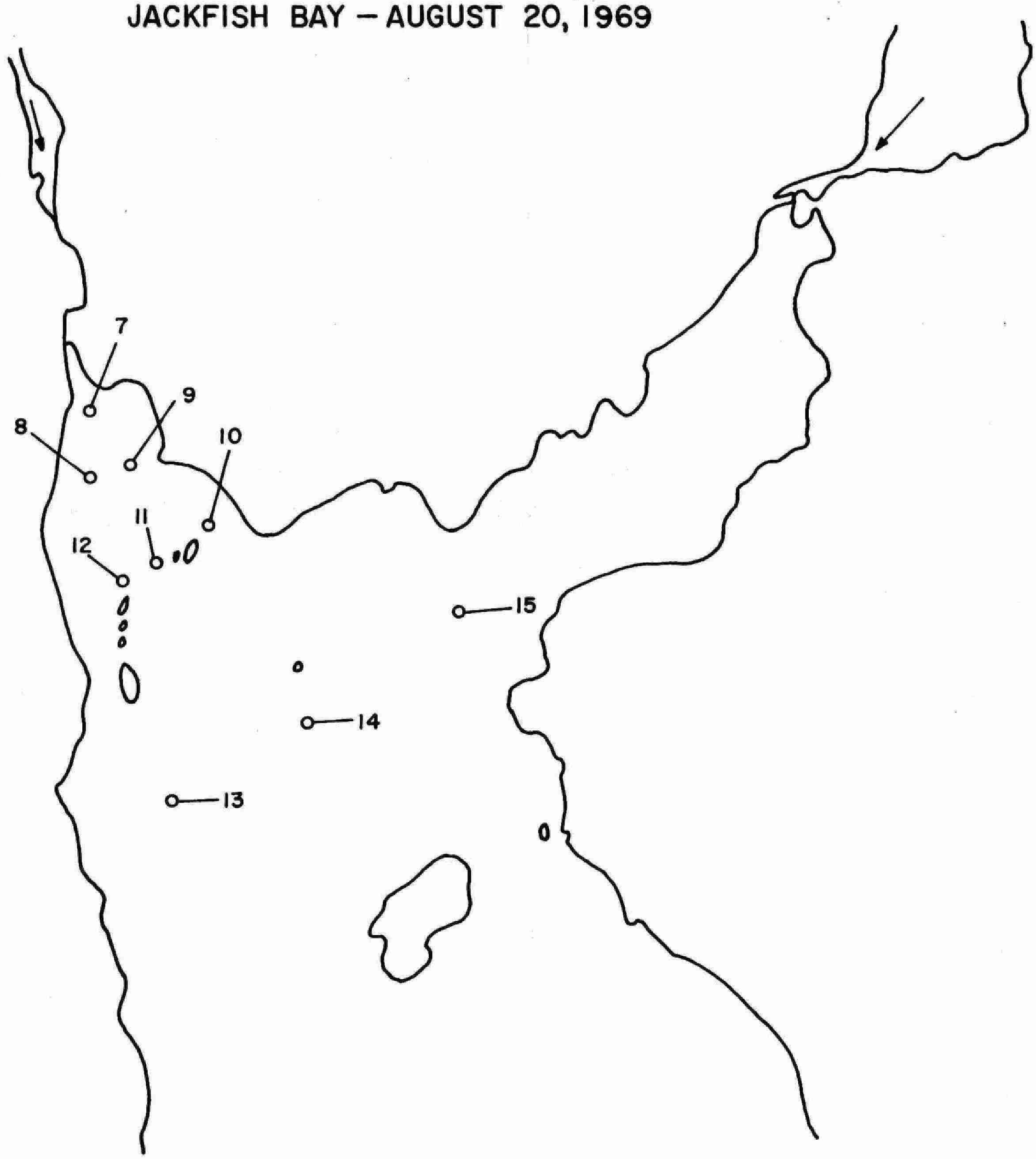
Chemical parameters of water quality examined at nine locations on Jackfish Bay were consistent with the biological findings. These results, provided in Figure 3, indicate concentrations of BOD, dissolved solids, phenols and colour units at stations 7, 8, 9, 11 and 12 on Moberly Bay which were in excess of the background levels present at stations 13, 14 and 15 on Jackfish Bay proper.

Characteristics of the substrate at each of the biological sampling stations are summarized in Table 2 of the Appendix.

Various combinations of gravel, sand, silt and clay form the natural sediments of Jackfish Bay. Throughout most of Moberly Bay the mineral sediments were covered by a gelatinous organic sludge having a putrid odour and a colour which varied from black to greenish brown. Wood fibre per se was not evident; however, these sludge deposits had all the characteristics of highly-decomposed pulp solids. The same or a similar sludge exists in the late recovery zone of many waters which receive pulp wastes. For example, McKenzie (1928) noted a similar material in the late recovery zone on the Winnipeg River

FIG. 3

ANALYTICAL RESULTS OF WATER SAMPLES OBTAINED FROM NINE SAMPLE SITES ON JACKFISH BAY — AUGUST 20, 1969



Station	BOD (ppm)	S.S. (ppm)	D.S. (ppm)	Phenol (ppb)	Colour Units
7	90	27	639	250	500
8	6.6	3	131	25	60
9	3.3	2	116	25	30
10	1.2	2	68	0	5
11	4.2	2	130	23	30
12	3.7	2	102	25	40
13	0.9	1	71	5	5
14	0.3	1	65	4	5
15	0.4	1	87	2	5

DWG. Nº : 70-71-8L

below the pulp mill at Kenora which he described as a thick, slimy mud containing very little actual pulp.

DISCUSSION

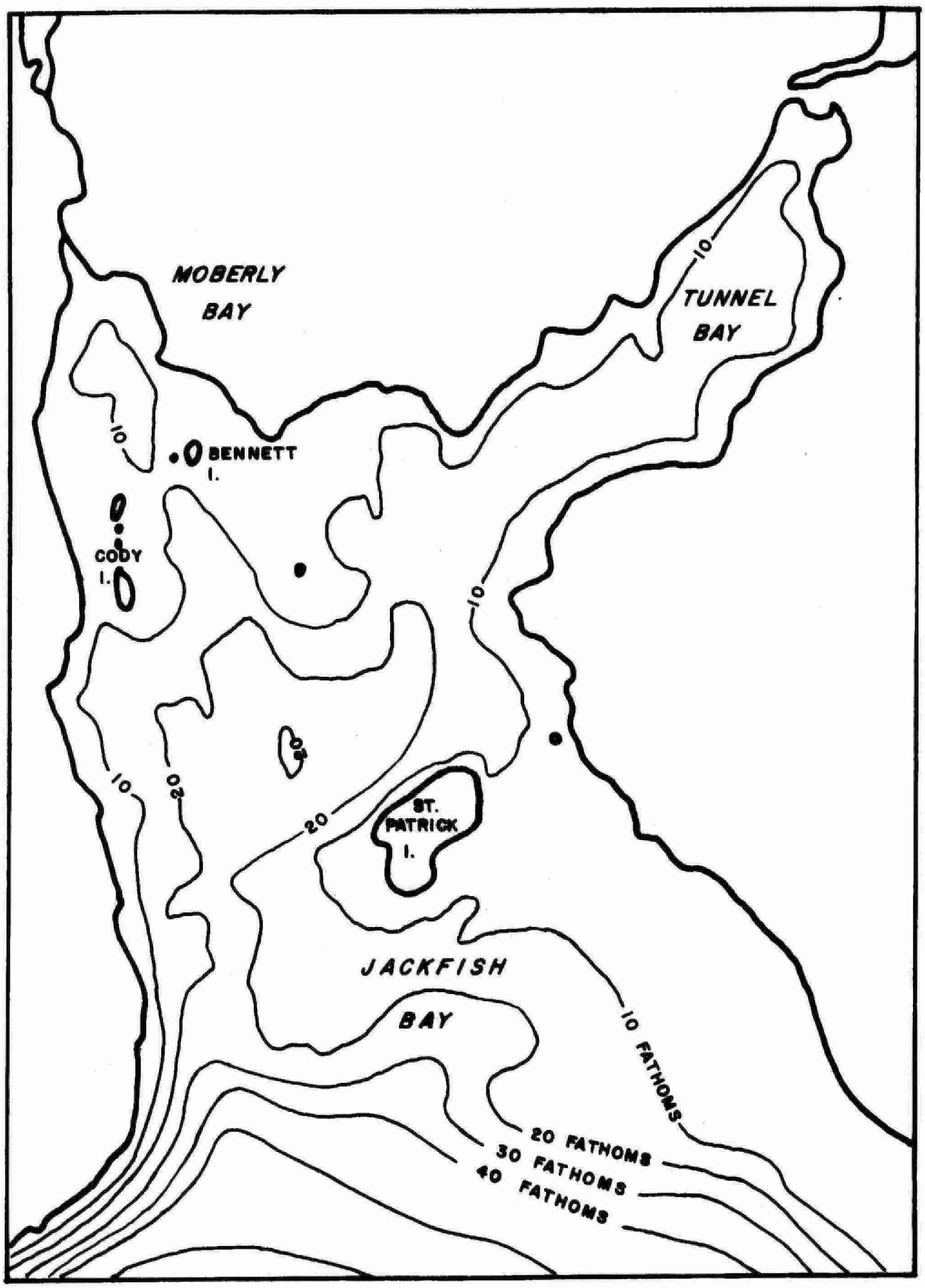
Findings of the biological survey support the conclusion that severe toxic pollution exists in Moberly Bay near the mouth of Blackbird Creek, benthal oxygen depletion persists throughout Moberly Bay and restoration of water quality adequate to support indigenous aquatic life occurs in Jackfish Bay at a distance of approximately 1-1/4 miles from the mouth of Blackbird Creek.

Superficially, the loss of Moberly Bay may appear insignificant relative to the total surface area of Lake Superior. However, it is recognized that the shallow near-shore waters of deep, cold lakes are important to fish populations since they are relatively more productive than deeper, off-shore waters. The shallow waters of areas such as Moberly Bay and those surrounding Bennet and Cody islands are important for their production of zooplankton and invertebrate species (see Figure 4).

Historically, Blackbird Creek has been regarded by the Company as their waste treatment system and Jackfish Bay as the effluent receiving water. To date, the Commission has neither accepted nor totally rejected this position; however, since there is no practical hope of recovery for the Creek/Lake system the only valid reason for rejecting the Company's position rests with the aesthetic problem along the Trans-Canada Highway. Barrying diversion of the stream or re-routing of the highway it is doubtful that the foam and colouration problem can be solved. The significant issue, in view of the findings of this survey, is that the Creek/Lake treatment system is ineffectual in protecting Moberly Bay from toxic and organic pollution.

FIG. 4

JACKFISH BAY DEPTH CONTOURS



DWG. Nº : 70-72-BL

At the present time the system is providing reasonably good removal of settleable solids (i.e. wood fibre); however, there is ample indication that the system is also faltering in this regard. For example, Rowley reported that at mill start-up in 1948, Lake 'A' occupied a surface area of 47 acres. In 1959, the same author reported that Lake 'A' was reduced in surface area to 26 acres with a volume of 3,640,000 cubic feet but still maintained 100% removal of suspended solids losses. In 1969, little of the original volume of Lake 'A' remained free of pulp solids and an industrial wastes survey of the Creek/Lake system reported that higher suspended solids concentrations occurred in the effluent leaving Lake 'A' than were present in the influent. Further, the industrial wastes survey revealed that the effluent discharge from the Creek/Lake system to Moberly Bay at the time of the survey did not comply with OWRC objectives in terms of 5-day bio chemical oxygen demand (BOD_5) and suspended solids concentrations.

REFERENCES

McKENZIE, R. A. 1930. The reported decrease in fish life and the pollution of the Winnipeg River, Kenora, Ontario. Trans. American Fish Society 60: 311-323.

ROWLEY, J. R. 1962. Mill waste disposal system at the Terrace Bay Ontario Mill of the Kimberly-Clark Corporation. Pulp Paper Magazine, Can. Convention Issue, 1962. T97-101.

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APPENDIX

Table 1. Bottom fauna collected at 108 sampling sites on Jackfish Bay during August, 1969.

Table 2. Substrate characteristics at 108 bottom fauna sampling sites on Jackfish Bay during August, 1969.

Table 1. Bottom fauna collected at 108 sampling sites on Jackfish Bay during August, 1969.

Stations \ Taxa	CADDISFLY	LIMNEPHILIDAE	HYDROPTILIDAE	*Triaenodes*	DIPTERA	TENDIPEDIDAE	HELEINAE	DECAPODA	*Mysis relicta*	ISOPODA	*Asellus militaris*	*Lirceus*	AMPHIPODA	*Pontoporeia affinis*	*Gammarus*	*Hyalla azteca*	MOLLUSCA	*Pisidium*	*Physa*	*Valvata*	SLUDGEWORMS	OLIGOCHAETA	LUMBRICULIDAE	Station Depth/ Feet
A 1																								2
2						1																1		4
3						3																31		32
4						3																12		54
5						2																49		15
6						10								1								330		25
7																						80		31
8						3					2											96		24
B 1																								3
2																								46
3																						90		60
4																						119		59
5						4																1500		49
6						12																47		35
7						13					1			1								30		44
C 1																								5
2																								46
3																						5		64
4																						37		62
5																						12		59
6						3																192		67
7						2																57		61
8														1								28		78
D 1																								5
2						4																83		31
3						15																43		46
4						15								1								129		38
5															2							126		36
6															1							30		34
7						16																650		54
E 1																								5
2																						27		10
3						2																21		12
4						3								1								32		12
5						2								10								24		24
6						2								9								4		24
7						8								4				3		1		33		27
F 1						6														1		24		109
2																						1		86
3						3								2								2		101
4											1											1		31

........continued.

Table 1. continued....

Stations	CADDISFLY	LIMNEPHILIDAE	HYDROPTILIDAE	*Triaenodes*	DIPTERA	TENDIPEDIDAE	HELEINAE	DECAPODA	*Mysis relicta*	ISOPODA	*Asellus militaris*	*Lirceus*	AMPHIPODA	*Pontoporeia affinis*	*Gammarus*	*Hyalla azteca*	MOLLUSCA	*Pisidium*	*Physa*	*Valvata*	SLUDGEWORMS	OLIGOCHAETA	LUMBRICULIDAE	Station Depth/ Feet
G 1						3																320		104
2						1			1					2								36		117
3						2					1			10	1							19		117
4						1								5								9		109
5						4			2					5								4		111
6						1								16								7		132
7														16				1				4		149
8						1								7								6		117
9						2			3					33				6						176
H 1						8								2								328		111
2						1					1			1					1			26		121
3														7								6		134
4						2			1													5		157
5									1					35								6		150
6														12								3		83
7														6								5		101
8														4				3				3		116
9						1								32				6				4		172
I 1						5								3								41		78
2																		1				36		124
3						1								32								6		136
4									1					12				1				3		133
5						4			1					23				1				2		140
6														2								1		78
7														1								4		66
8														5				3						118
9						1								27				4						230
J 1						1																170		86
2														4								31		149
3														6								1		56
4														15								13		123
5						3			2					15				2				3		145
6						2								13										31
7														10										36
8														16										45
K 1						1								4				1				13		75
2														6				1				5		63
3						1								7				3				11		73
4						3			2					30				6				36		127
5						13								5								171		68
L 1														11								22		30
2						1								14				3				8		52
3						2								10				4						54
4						1			1					27				3	1			7		80

......continued.....

Table 1. continued....

Stations	CADDISFLY	LIMNEPHILIDAE	HYDROPTILIDAE	*Triaenodes*	DIPTERA	TENDIPEDIDAE	HELEINAE	DECAPODA	*Mysis relicta*	ISOPODA	*Asellus militaris*	*Lirceus*	AMPHIPODA	*Pontoporeia affinis*	*Gammarus*	*Hyalla azteca*	MOLLUSCA	*Pisidium*	*Physa*	*Valvata*	SLUDGEWORMS	OLIGOCHAETA	LUMBRICULIDAE	Station Depth/ Feet
M 1						5								11								10		17
2														18								1		96
3						1								18								4		101
4						7								8								3		42
N 1						1								26	1			7				11		85
2						3			1					19								12		80
3														5		2		3				6		8
O 1														33				1						56
2														19								21		64
3				1		5					5			22				7				7		17
P 1			1			1								38				2						45
2														6										86
3		1				7	1					5		29		5				1		54		10
Q 1						14					2			15						1		19		22
2						6								36								8		108
3									3					42								2		112
4						1			4					17								7		105
R 1						2								18								2		70
2						1								10										66
3						3					13			35								4		28
S 1						2					30	5		54	8							29		5
2						3					1			46						1		30		6
3						26								11								22	2	5

Table 2. Substrate characteristics at 108 bottom fauna sampling sites on Jackfish Bay during August, 1969.

Station	Substrate characteristics	Station	Substrate characteristics
A1	75% organic sludge-sand, gravel	E1	Sand
A2	75% organic sludge-sand, gravel	E2	Sand, clay
A3	25% organic sludge-sand	E3	Sand, clay
A4	25% organic sludge-sand, clay	E4	Sand
A5	Sand	E5	Sand
A6	Sand	E6	Sand, clay
A7	Sand, gravel	E7	Sand, clay
A8	Sand, gravel		
B1	75% organic sludge-sand	F1	Silt, clay
B2	100% organic sludge	F2	Gravel
B3	20% organic sludge-sand, clay	F3	Sandy silt
B4	10% organic sludge-sandy silt	F4	Sand, clay
B5	5% organic sludge-sandy silt		
B6	Sand	G1	Silt, clay
B7	Sand, clay	G2	Silt, clay
		G3	Sand, clay
C1	10% organic sludge-sand	G4	Clay
C2	100% organic sludge	G5	Silt, clay
C3	10% organic sludge-sand, clay	G6	Silt, clay
C4	5% organic sludge-silt, clay	G7	Clay
C5	5% organic sludge-sandy silt	G8	Gravel, clay
C6	25% organic sludge-sandy clay	G9	Sandy silt, clay
C7	Sand, clay		
C8	Silt, clay	H1	Silt, clay
		H2	Silt, clay
D1	5% organic sludge-sand clay	H3	Silt, clay
D2	Silt	H4	Silt, clay
D3	5% organic sludge-silt, clay	H5	Silt, clay
D4	5% organic sludge-sand, clay	H6	Clay
D5	5% organic sludge-sandy silt	H7	Sand
D6	Sand	H8	Sand
D7	Sand, clay	H9	Sand
		I1	Clay
		I2	Clay
		I3	Clay
		I4	Clay
		I5	Clay
		I6	Sand
		I7	Sand, gravel
		I8	Clay
		I9	Clay
		J1	Silt, clay
		J2	Silt, clay
		J3	Silt, clay
		J4	Clay
		J5	Clay
		J6	Sand
		J7	Sand
		J8	Sand

continued.....

Table 2. continued.

Station	Substrate characteristics	Station	Substrate characteristics
K1	Silt, clay	O1	Clay
K2	Sand	O2	Clay
K3	Sandy silt	O3	Sandy silt
K4	Silt, clay		
K5	Silt, clay	P1	Clay
		P2	Clay
L1	Silt, gravel, clay	P3	Sand, clay
L2	Sand, clay		
L3	Sandy silt, clay	Q1	Silt, clay
L4	-	Q2	Silt, clay
		Q3	Silt, clay
M1	Sand	Q4	Silt
M2	Silt, clay		
M3	Silt, clay	R1	Silt
M4	Sand, gravel	R2	Silt, clay
		R3	Silt
N1	Silt, clay		
N2	Silt, clay	S1	Sand, clay
N3	Sand	S2	Sand, clay
		S3	Sand, clay